WASHINGTON STATE TRANSPORTATION CENTER

Washington State University
Pullman, WA 99164-2910

TO:	James P. Toohey Research Office Washington State Department of Transportation
TYPE OF SUPPORT REQUESTED:	Research
TITLE OF PROJECT:	Field Evaluation of a Cost Effective Method to Retrofit Stormwater Dry Wells Using Permeable Reactive Barriers
AGENCY CONDUCTING WORK	Department of Civil and Environmental Engineering Washington State University Pullman, WA 99164-2910
PRINCIPAL INVESTIGATORS:	David Yonge and Akram Hossain
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UNIVERSITY OFFICE TO BE CONTACTED FOR NEGOTIATION OF AWARD:	Office of Grant and Research Development
DATE: March 25, 1998	_____ David Yonge Principal Investigator
	_____ Rafik Itani, TRAC Director Department of Civil and Environmental Engineering
	_____ Anjan Bose, Dean College of Engineering
OFFICIAL AUTHORIZED TO GIVE UNIVERSITY APPROVAL: Grant and	_____ Daniel Nordquist, Acting Director, Office of Research Development

FIELD EVALUATION OF A COST EFFECTIVE TO RETROFIT STORMWATER DRY WELLS USING PERMEABLE REACTIVE BARRIERS

by

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Submitted to:

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Washington State Department of Transportation

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PROBLEM STATEMENT

The Washington State Department of Transportation (WSDOT) has constructed hundreds of dry wells for the disposal of highway storm water runoff, many of which now lie within sole source aquifer and wellhead protection areas. Dry wells are deep slotted concrete sumps designed to facilitate the rapid infiltration of stormwater, and are classified as Class V underground injection wells under federal regulations in the Code of Federal Regulations (CFR) part 144. Dry wells have historically been important stormwater disposal options in eastern Washington and the glacial outwash plains in western Washington. Although current design standards mandate pre-treatment of storm water disposal to dry wells for a 6 month / 24 hour storm event, many older facilities are without this added level of protection for ground water resources. The US Environmental Protection Agency (EPA) has indicated that transportation improvement projects will have to address methods to retrofit dry wells in the future so that groundwater will not be impacted by stormwater runoff or toxic spills on state highways. A cost effective dry well retrofit strategy is needed to assist in project delivery in those areas where dry wells are present. Such a strategy is proposed in this document, keying on field performance of the stormwater permeable reactive infiltration barrier (SPRIB).

OBJECTIVES

The primary objective of the proposed work is to generate a data base regarding the fate of selected stormwater contaminants in an inorganic filtration/sorption media, termed the stormwater permeable reactive infiltration barrier (SPRIB), contained in a flow-through device that could be used for pretreatment or could be inserted in existing dry wells. The information would be used to define the efficacy of this device to retain stormwater constituents of concern. The information would be collected in a field setting in Spokane, Washington. The project objective would be realized by performing the following specific project tasks.

- Perform a detailed literature review regarding contaminant retention and groundwater pollution potential exhibited by dry wells, existing pretreatment processes used for dry wells, and information relating to permeable reactive barriers.

- Develop a field sample collection protocol that will allow for the automatic collection of representative influent and effluent SPRIB samples.

- Select a dry well site in Spokane, WA

- Install the SPRIB device at the site and instrument the site for automatic sample and data collection.

- Perform tracer tests during storm events to define actual detention time afforded by the SPRIB.

METHODS

The United States Geologic Survey (USGS) has developed an inorganic filtration/sorption media, called the stormwater permeable reactive infiltration barrier (SPRIB) as part of a WSDOT sponsored research project funded in the 1997 - 1999 biennium. Originally, SPRIB was developed to be used as a liner in infiltration ponds where soils have very high infiltration rates and space for installing water quality pretreatment BMPs was lacking. Essentially, the SPRIB technology permits projects to use the same infiltration facility for both water quality treatment and flow control. SPRIB was designed to treat highway stormwater runoff to groundwater quality standards when the stormwater infiltrates through 18 inches of the media. SPRIB has been extensively tested in the laboratory and in pilot scale trials, but has not been tested at an actual transportation stormwater facility.

The retrofit strategy for dry wells would consist of spill control devices in catch basins to prevent release of spills to dry wells, followed by the SPRIB system in the dry well itself. The SPRIB system would consist of a drainage gravel base that fills the dry well up to the uppermost discharge port, then a minimum of 18" of the SPRIB media would overlay the drainage gravel. The catch basin-contained spill control units would remove most oil and grease and floatable materials while the SPRIB layer would remove solids and heavy metals so that the resultant elutriate would meet Washington groundwater quality standards. In this proposal a state highway drainage system that uses dry wells for stormwater disposal would be retrofitted with the SPRIB system and monitored to verify performance. As part of the proposed project, benefit to cost performance and life-cycle

maintenance requirements for the SPRIB system would be estimated in addition to its water quality treatment efficiency.

1.1. Site Selection

Site selection will be finalized during the first phase of the proposed project and, consequently, no specific site is recommended in this proposal. However, the site will be located in Spokane, WA and will be selected with input from WSDOT personnel and Spokane County officials.

1.2. Stormwater Monitoring

Simultaneous with site selection, an automated sample collection system will be developed in the laboratory. This system will result in a method of collecting representative samples during storm events, from the influent and effluent of the SPRIB unit. The device will be developed and tested in a laboratory setting prior to field installation. Automated sampling and continuous data collection (flow, conductivity, pH, and temperature) will be afforded by a Sigma 900 portable sampler system and a Sigma 960 flow meter/data logger with associated probes. The sampler and data logger are battery operated and the batteries are automatically charged using solar panels. The data can be downloaded remotely using a cellular telephone system. The sampler can be initiated to collect water samples by programming a set point trigger, such as conductivity or flow.

1.2.1. Sample analysis

It is proposed that samples collected during storm events be analyzed for the constituents listed in Table 1. The constituent list may be modified pending discussion with WSDOT personnel. Soluble and total available metals will be analyzed using standard EPA protocol and an ICP/MS. We propose to assess toxicity using the Microtox® acute toxicity testing protocol.

Table 1. Proposed constituent analysis for SPRIB influent and effluent stormwater.

Constituent	Water
TSS	X
Metals[1]	X
Chloride	X
pH	X
Alkalinity	X
TDS	X
Conductivity	X
Toxicity[3]	X

[1] Na, Ca, Mg, Cu, Pb, Zn, Cd, Fe

[2] Toxicity test performed using Microtox® bioassay protocol

1.3. Conservative Tracer Testing

Inert tracer tests will be performed on three occasions over the course of the study to assess any changes in short circuiting and hydraulic conductivity. Selection of an appropriate tracer will be made during the literature review phase of the project.

1.4. Monitoring SPRIB Headloss

A method of quantifying headloss buildup across the SPRIB media will be developed as part of the automated sample collection protocol development. This will allow a means of assessing permeability loss over the duration of operation and will yield valuable information regarding life cycle maintenance requirements.

POTENTIAL BENEFITS

If proven to be effective, the SPRIB system should reduce project costs while protecting groundwater supplies. If the performance of the SPRIB system is verified, it would allow projects to retrofit drainage systems without major structural modifications and would eliminate project costs the would ordinarily be used to remove the existing dry wells and install alternative stormwater drainage and treatment systems, such as infiltration basins.

PRODUCTS

The end product of the proposed effort will be a database that would be used to evaluate the effectiveness of the SPRIB system to remove stormwater contaminants under field conditions. In addition, life cycle maintenance data would be collected. These data would

be used by WSDOT to evaluate the applicability of this dry well treatment system as a runoff BMP. This information will be presented in a final report and a "seminar-type" presentation at WSDOT.

STAFFING PLAN

The principal investigator for this project will be Dr. David Yonge, Professor of Civil and Environmental Engineering. His general area of expertise is physical/chemical water and wastewater treatment, contaminant partitioning and adsorption, and fate of contaminants in the environment. Dr. Yonge will commit approximately 15 percent of his time during the academic years and approximately 50 percent during the summers to this project. Dr. Akram Hossain has expertise in subsurface sampling techniques and will provide valuable assistance in developing a sampling protocol and will be involved in data interpretation.

One masters level graduate research assistant will assist in all phases of this project. The student targeted for the proposed project (Piper Roelen) has worked in an environmental consulting firm for a number of years and has significant practical experience and enjoys fieldwork. He will make a significant contribution to the project.

Table 2. **Level of Effort (percent)**

Personnel	**Phase 1: Lit. Review**	**Phase 2: Data Collection**	**Phase 3: Data Interpretation**	**Phase 4: Report Development**	**Total**
D. Yonge	10	20	40	30	100
Co-PI	5	20	40	35	100
RA	15	30	40	15	100
Time slip		50	50		100